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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/698,170	10/30/2003	Sei-Hyung Ryu	5308-279	2502
20792	7590	05/10/2006	EXAMINER	
MYERS BIGEL SIBLEY & SAJOVEC PO BOX 37428 RALEIGH, NC 27627			TRAN, LONG K	
			ART UNIT	PAPER NUMBER
			2818	

DATE MAILED: 05/10/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/698,170	RYU, SEI-HYUNG	
	Examiner	Art Unit	
	Long K. Tran	2818	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 28 February 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-30 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-10, 12-20 and 22-30 is/are rejected.
- 7) ☒ Claim(s) 2, 11 and 21 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413). |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date <u>10/30/03, 2/20/04</u> . | 6) <input type="checkbox"/> Other: _____ |

IDS: 8/13/04, 3/17/05, 4/29/05

DETAILED ACTION

Election/Restrictions

1. The Restriction requirement in the previous Office Action on January 30, 2006 has been withdrawn by the examiner.

Claim Objections

2. Claim 2 is objected to because of the following informalities: line 2: "the first p-type" should be --the n-type--. Typo error. Appropriate correction is required.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims 1 – 4, 6, 12, 13, 15, 16, 18 – 20, 22, 23 and 27 – 29 are rejected under 35 U.S.C. 102(e) as being anticipated by Saitoh et al. (US Patent No. 6,700,156).
5. Regarding claims 1, 27, 28 and 29, Saitoh, in figures 1, 40B – 41E, discloses a silicon carbide metal-oxide semiconductor field effect (MOSFET) transistor unit cell, comprising:
 - an n⁻-type silicon carbide drift layer (11; column 28, lines 39 – 46);
 - a first p-type silicon carbide well regions (12) adjacent the drift layer (11) and spaced apart;

a first n-type silicon carbide region (13) within the first p-type silicon carbide region (12);

an oxide layer (23) on the drift layer (11), the first p-type silicon carbide region (12), and the first n-type silicon carbide region (13); and

a first n-type silicon carbide limiting region comprises a first portion (11a), disposed between the drift layer (11) and a portion of the first p-type silicon carbide (12), and a second portion (11b) adjacent spaced apart well regions (12) and the drift layer (11), wherein the n-type limiting region (11a) and between wells has a carrier concentration (n) that is greater than a carrier concentration (n^-) of the drift layer (11).

Regarding claim 2, Saitoh discloses the portion of the first n-type silicon carbide region (11a) is adjacent a floor of the first p-type silicon carbide region (12).

Regarding claim 3, Saitoh discloses the n-type limiting region (11b; column 21, lines 66 – 67) is disposed adjacent a sidewall of the first p-type silicon carbide region (12).

Regarding claim 4, Saitoh discloses the n-type limiting region comprises the first portion (11a) and the second portion ((11b); adjacent to the sidewall of the first p-type silicon carbide (12)) and wherein the first portion (11a) has a carrier concentration greater than a carrier concentration of the second portion ((11b); column 21, line 66 – 67 and column 22, lines 1 – 3).

Regarding claim 6, Saitoh discloses MOSFET comprising:

a gate contact (24) on the oxide layer (23);

Source contact (22) on the first n-type silicon carbide region (13); and

Drain contact (21) on the drift layer (11; column 5, lines 36 – 51) opposite the oxide layer (23).

Regarding claims **12** and **19**, Saitoh discloses the n-type limiting (third) silicon carbide regions (11a) comprising implanted n-type regions in the drift layer (column 22, lines 18 – 22).

Regarding claim **15**, Saitoh discloses a silicon carbide metal-oxide semiconductor field effect transistor (MOSFET) comprising:

- a drift layer of n-type silicon carbide (11);

- first regions (12) of p-type silicon carbide adjacent the drift layer (11);

- a first region of n-type silicon carbide (11b) disposed between peripheral edges of the first regions (12) of p-type silicon carbide;

- second regions of n^+ -type silicon carbide (13) within the first regions of p-type silicon carbide (12), wherein the second regions of n^+ -type silicon carbide have a carrier concentration greater than a carrier concentration (n^-) of the drift layer and are spaced apart from the peripheral edges of the first regions of p-type silicon carbide (12);

- an oxide layer (13) on the drift layer, the first region of n-type silicon carbide (11b) and the second regions of n-type silicon carbide (13);

- third regions of n-type silicon carbide (11a) disposed beneath the first regions of p-type silicon carbide (12) and between the first regions of p-type silicon carbide (12) and the drift layer (11), wherein the third regions of n-type silicon carbide (11a) have a carrier concentration (n) greater than the carrier concentration (n^-) of the drift layer (11);

source contacts (22) on portions of the second regions (13) of n-type silicon carbide;

a gate contact (24) on the oxide layer (23) ; and

Drain contact (21) on the drift layer (11; column 5, lines 36 – 51) opposite the oxide layer (23).

Regarding claim **16**, Saitoh discloses the third regions of n-type silicon carbide are adjacent the peripheral edges of the first regions of p-type silicon carbide (12).

Regarding claim **18**, Saitoh discloses the first region of n-type silicon carbide (11b) comprise a region of the drift layer (11).

Regarding claim **20**, Saitoh discloses the first region of n-type silicon carbide (11b) has a higher carrier concentration (n) than a carrier concentration (n^-) of the drift layer and has a lower carrier concentration than a carrier concentration (n) of the third regions of n-type silicon carbide (11a). see column 21, line 66 – 67 and column 22, lines 1 – 3.

Regarding claims **13** and **22**, Saitoh discloses an n-type silicon carbide layer (15) between the drift layer (11) and the drain contact (21), wherein the n-type silicon carbide layer has a higher carrier concentration (n^+) than the carrier concentration (n^-) of the drift layer (11).

Regarding claim **23**, Saitoh discloses the n-type silicon carbide layer comprises an n-type silicon carbide substrate (column 5, lines 52 – 57 and column 28, lines 44 – 48).

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

7. Claims **9, 10, 25** and **26** are rejected under 35 U.S.C. 103(a) as being unpatentable over Saitoh et al. (US Patent No. 6,700,156).

8. Regarding claims **9, 25** and **26**, Saitoh discloses all limitations of claim 1 or 15 but fails to teach the limiting (third) regions of n-type silicon carbide have a thickness of from about 0.5 to about 1.5 micrometers and a carrier concentration of from 1×10^{15} to about $5 \times 10^{17} \text{ cm}^{-3}$.

However, it would have been well known in the art that the selection of those parameters such as **energy, concentration, temperature, time, molar fraction, depth, thickness, etc.**, would have been obvious and involve routine optimization which has been held to be within the level of ordinary skill in the art. "Normally, it is to be expected that a change in **energy, concentration, temperature, time, molar fraction, depth, thickness, etc., or in combination of the parameters** would be an unpatentable modification. Under some circumstances, however, changes such as these may impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from the results of the prior art ... such ranges are termed "critical ranges and the applicant has the burden of proving such criticality.... More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.

Regarding claim **10**, Saitoh discloses the claimed invention of claims 1 and 6 except for the gate contact comprising polysilicon or metal.

However, polysilicon and metal are well known material in the art used for gate electrode and gate contact. Reference to Alok et al. (column 5, lines 49 – 51) is cited merely for purpose of showing an example, but not used in the rejection.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide Saitoh MOSFET with well known polysilicon or metal as a gate contact, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use.

9. Claims **1, 5, 6, 10, 14,15** and **24** are rejected under 35 U.S.C. 103(a) as being obvious over Ryu et al. (US Patent Application Publication No. 2002/0038891 in view of Saitoh et al. (US Patent No. 6,700,156).

10. Regarding to claims **1** and **15**, Ryu, in figure 1B, discloses a silicon carbide metal-oxide semiconductor field effect transistor (MOSFET) comprising:

- a drift layer of n-type silicon carbide (N^- drift layer);
- first regions of p-type silicon carbide adjacent the drift layer ;
- a first region of n-type silicon carbide disposed between peripheral edges of the first regions of p-type silicon carbide;
- second regions of n^+ -type silicon carbide (N^+) within the first regions of p-type silicon carbide, wherein the second regions of N^+ -type silicon carbide have a carrier concentration greater than a carrier concentration (N^-) of the drift layer and are spaced apart from the peripheral edges of the first regions of p-type silicon carbide;
- an oxide layer on the drift layer, the first region of n-type silicon carbide and the second regions of n-type silicon carbide;
- source contacts on portions of the second regions of n-type silicon carbide;
- a gate contact on the oxide layer; and
- drain contact on the drift layer opposite the oxide layer.

Ryu fails to teach third regions of n-type silicon carbide disposed beneath the first regions of p-type silicon carbide and between the first regions of p-type silicon carbide and the drift layer, wherein the third regions of n-type silicon carbide have a carrier concentration greater than the carrier concentration of the drift layer.

However, Saitoh discloses a similar MOSFET to the claimed invention including third regions of n-type silicon carbide (11a) disposed beneath the first regions of p-type silicon carbide (12) and between the first regions of p-type silicon carbide (12) and the drift layer (11), wherein the third regions of n-type silicon carbide (11a) have a carrier concentration (n) greater than the carrier concentration (n^-) of the drift layer (11) to prevent resistance from expanding to the broad n⁻-type drift layer (11) from JFET region interposed between the p-type base layer (12). See column 7, lines 29 – 38.

It would have been obvious to one of ordinary skill in the art at the time of the invention was made to provide the MOSFET of Ryu with the n-type limiting region (11a) of Saitoh, in order to reduce the resistance between adjacent p-type base layer.

Regarding claim 5, the combined Ryu and Saitoh device includes the first p-type silicon carbide region is implanted with aluminum (Ryu: paragraph [0017]).

Regarding claim 6, the combined Ryu and Saitoh device, particularly Saitoh in figures 1, 40B – 41E, comprising:

a gate contact (24) on the oxide layer (23);

Source contact (22) on the first n-type silicon carbide region (13); and

Drain contact (21) on the drift layer (11; column 5, lines 36 – 51) opposite the oxide layer (23).

Regarding claims 7, 8, 17 and 30, the combined Ryu and Saitoh device, particularly Saitoh, appears to include the n-type region comprising an epitaxial layer silicon carbide on the drift layer (11), and wherein the p-type well regions (12) are disposed in but not through the epitaxial layer.

Regarding claim **10**, the combined Ryu and Saitoh device comprising gate contact is polysilicon (Ryu, paragraph [0019]).

Regarding claims **14** and **24**, the combined Ryu and Saitoh device includes a second p-type silicon carbide region disposed within the first p-type silicon carbide region adjacent to the first n-type silicon carbide region (Ryu, figure 1B).

Allowable Subject Matter

11. Claims **11** and **21** are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

12. The following is an examiner's statement of reasons for the indication of allowable subject matter: Claims **11** and **21** are allowable over the prior art of record because none of the prior art whether taken singularly or in combination, especially when these limitations are considered within the specific combination claimed, to teach:

An n-type epitaxial layer (27) on the first p-type silicon carbide region (20) and the first region of n-type silicon carbide (24).

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Long K. Tran whose telephone number is 571-272-1797. The examiner can normally be reached on Mon-Thu.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Nelms can be reached on 571-272-1787. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

LKT

May 07, 2006

A handwritten signature in black ink, appearing to be 'LKT', with a long horizontal line extending to the right.